# SYLVANIA

# TELEVISION OSCILLOSCOPE

## TYPE 400

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# OPERATING MANUAL

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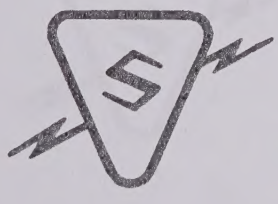

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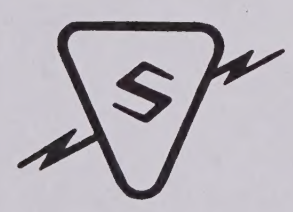

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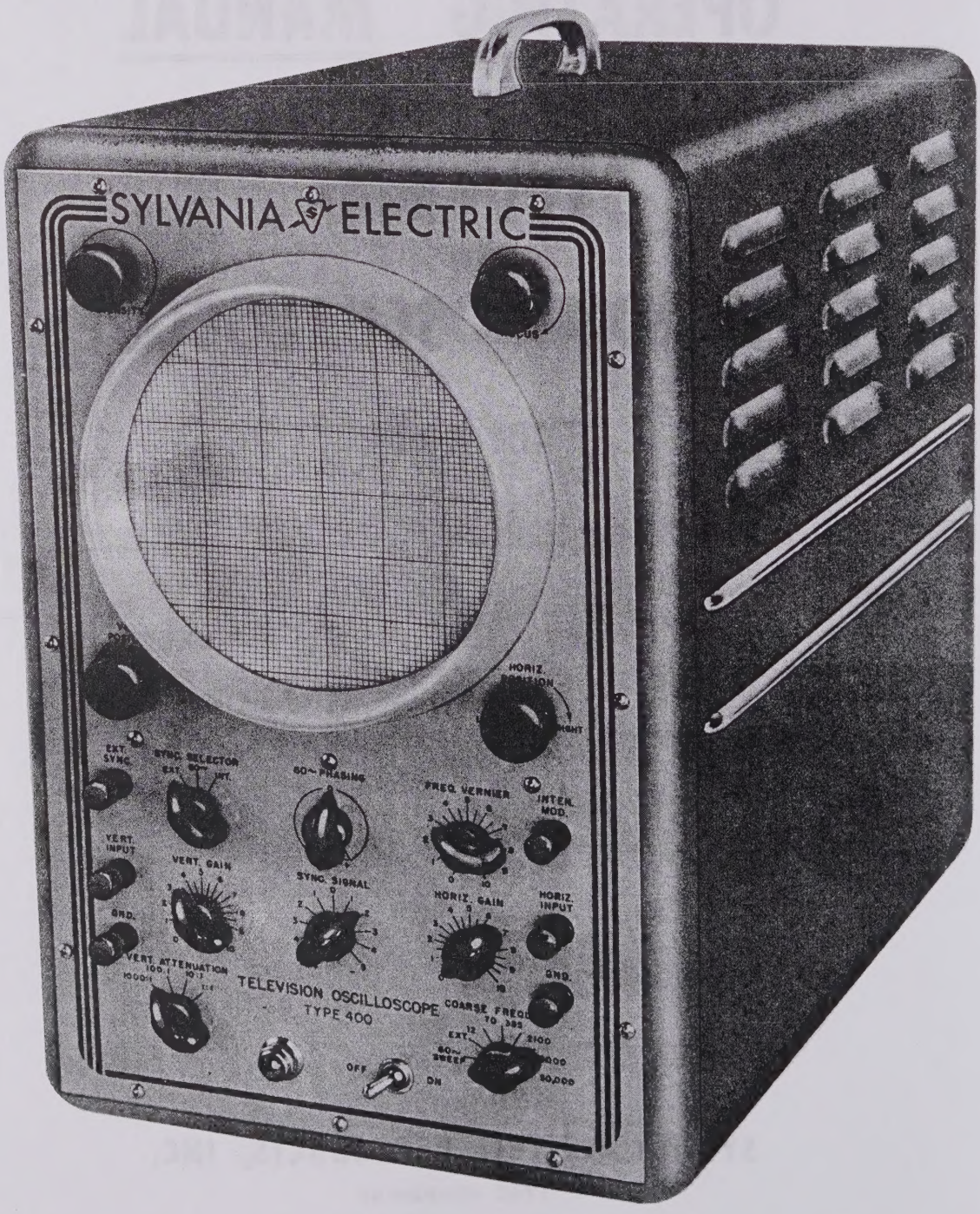


The Sylvania Television Oscilloscope Type 400, Less Leads.

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# SYLVANIA TELEVISION OSCILLOSCOPE TYPE 400

## GENERAL DESCRIPTION

The Sylvania Television Oscilloscope Type 400 is intended for use in observing rapid pulses, square waves, and special wave forms, especially those occurring in television receivers, and is designed particularly for use of the television serviceman. Its bandwidth from 10 cycles to 2 mc (within 3db), and sensitivity of 10 millivolts makes it valuable in laboratory and production applications. The multivibrator sweep circuit provides linear internal sweep from 15 cycles to 50 kilocycles, and may be synchronized to either positive or negative signals. A phase shifter provides continuous shift, from at least plus 88 degrees to minus 88 degrees, in the signal from the internal 60 cycle sine wave sweep source. A capacitively compensated step attenuator having 4 steps, and a low impedance attenuator, gives a wide range of gain control without distortion. The large 7″ tube makes an easily read display possible, and expansion of the horizontal trace to almost twice the tube face width permits detailed examination of particular portions of the trace. Balanced and non-astigmatic sweep is ensured by use of push-pull deflection. Acceleration voltage of 2200 volts provides bright trace even at rapid writing speeds. Terminals are brought out for direct connection to both horizontal and vertical deflection plates, if desired, and to the control grid of the cathode ray tube for intensity modulation.

## QUICK REFERENCE DATA

1. Power line requirements: 105 to 125 volts, 50 to 60 cycles. Uses 200 watts at 117 volts 60 cycles.

2. Tube complement:

   One Sylvania Type 7JP1, Cathode ray tube.
   One Sylvania Type 12AU7, Push-pull vertical amplifier driver.

   Four Sylvania Type 12AT7, Vertical input cathode follower/first vertical amplifier, horizontal input cathode follower/horizontal phase splitter cathode follower, sweep generator, positive and negative sync amplifier/electronic filter.

   Two Sylvania Type 7A5, Vertical deflection amplifiers.

   Two Sylvania Type 7C5, Horizontal deflection amplifiers

   One Sylvania Type 2X2A, High voltage rectifier.

   One Sylvania Type 50X6, Low voltage rectifier.

   One Sylvania Type 6AU6, Vertical amplifier.

3. Accelerating Potential 2200 volts.

4. Input Impedances:

   A. Vertical amplifier: 5 megohms, 26 mmf.

   B. Horizontal amplifier: 5 megohms, 31 mmf.

   C. Direct to horizontal or vertical plates: 4.7 megohms, 16 mmf.

5. Amplifier Frequency Response:

   A. Vertical: Sine wave 10 cycles to 2 megacycles, within 3 db. Square waves of any frequency between 50 cycles and 50 kilocycles will be reproduced accurately with negligible phase shift or overshoot

   B. Horizontal: Sine wave, 10 cycles to 600 kilocycles, within 3 db.

6. Amplifier Sensitivity.

   A. Vertical: Ten millivolts (.010 volts) rms sine wave for one inch peak-to-peak deflection.

   B. Horizontal: One half volt rms sine wave for one inch peak-to-peak deflection.

7. Direct Input Sensitivity.

   A. Vertical Plates (D3 and D4): 24 volts rms sine wave for one inch peak-to-peak deflection. (34 volts dc per inch).

   B. Horizontal Plates (D1 and D2): 26 volts rms sine wave for one inch peak-to-peak deflection. (36 volts dc per inch).

8. Vertical Gain Controls:

   Compensated decimal step attenuator and low impedance 10:1 smooth attenuator. Maximum attenuation, 10,000:1.

9. Direction of Sweep: Left to right.

10. Deflection: Beam deflected to the *left* by a positive external signal to the HORIZ. INPUT connector. Beam deflected *up* by a positive signal to the VERT. INPUT connector

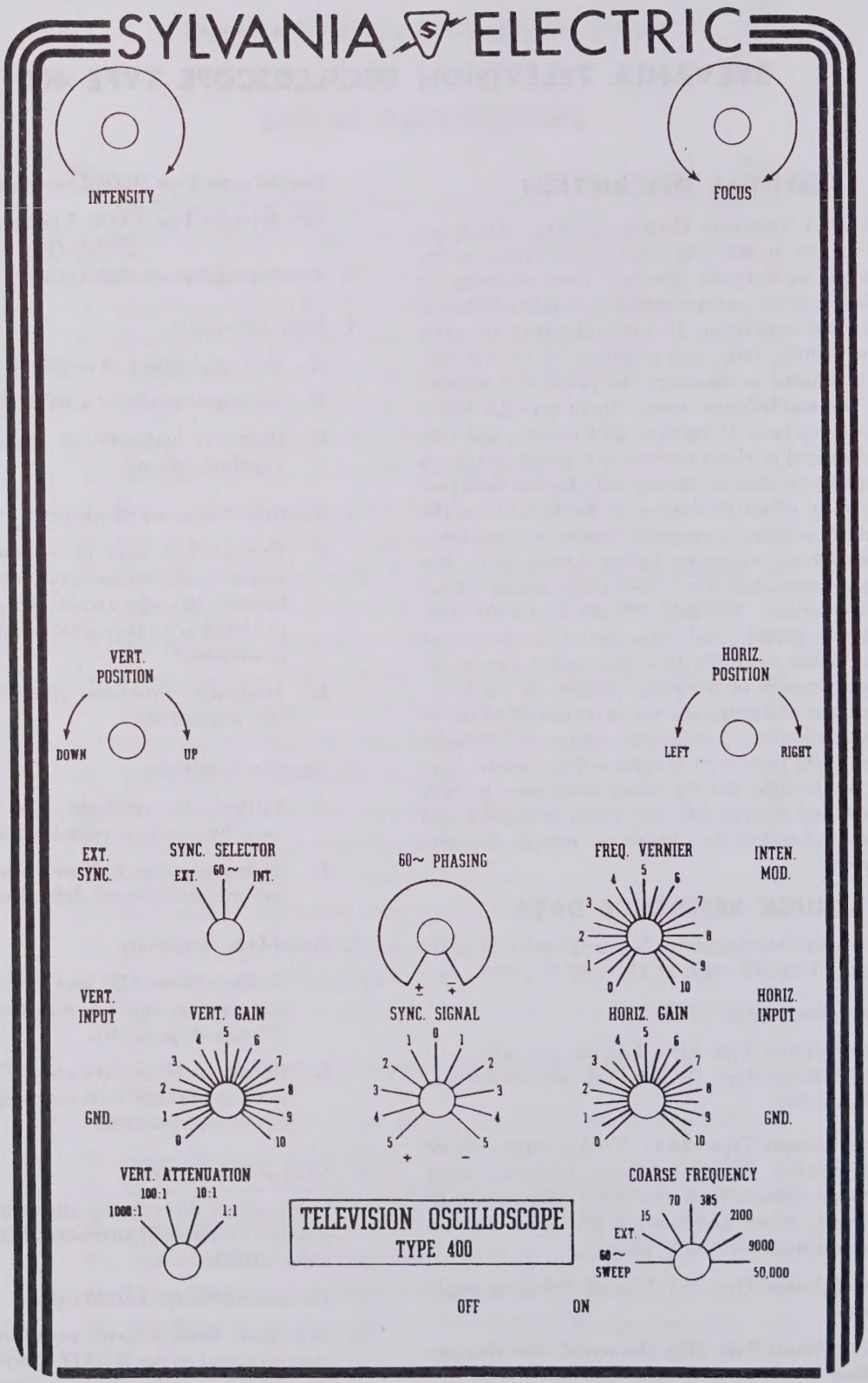



Fig. 1—The front panel layout of the Television Oscilloscope Type 400. The controls are located for most convenient operation.

11. Sweep Synchronization: Phase inverter type. Variable in amplitude and polarity.

12. Maximum dc voltage permissible at VERT. INPUT terminal: 600 volts.

13. Maximum ac signal voltage permissible at VERT. INPUT terminal: 700 volts rms.

14. Maximum ac signal voltage permissible at HORIZ. INPUT terminal: 25 volts rms (direct input to cathode follower grid).

15. Sweep rate: 15 cycles to 50 kilocycles.

16. Cabinet Size: 17-1/16" high, 11⅜" wide, and 17¾" deep.

17. Weight: 45 pounds.

## OPERATING INSTRUCTIONS

NOTE: To obtain proper results with your oscilloscope, it is advisable to familiarize yourself with the panel controls by making some simple tests. These tests will assure you that your oscilloscope is in proper working condition.

1. To Make Preliminary Tests of Control Functions:

   A. Set the following controls to approximately *half scale*:

      1. FOCUS
      2. VERT. POSITION
      3. HORIZ. POSITION
      4. 60 CYCLE PHASING
      5. FREQ. VERNIER
      6. SYNC. SIGNAL

   B. Set VERT. GAIN and HORIZ. GAIN to 0 position.

   C. Set VERT. ATTENUATION to 100:1

   D. Set COARSE FREQUENCY to the line between 70 and 385. This gives the FREQ. VERNIER control a range from 70 to 385 cycles.

   E. Set the FREQ. Vernier to about 2.

   F. Set the SYNC. SELECTOR to INT.

   G. Turn the unit on, and gradually increase the INTENSITY control setting until a dot appears somewhere on the screen of the cathode ray tube. If the dot does not appear (after about half a minute warm-up of the instrument), move the VERT. POSITION and HORIZ. POSITION controls slightly, as it may be off screen.

   H. Adjust the VERT. POSITION and HORIZ. POSITION controls until the dot is in the exact center of the screen, and adjust the FOCUS control for sharpest image. Usually the finest focus is obtained at low intensity.

   I. Now slowly increase the HORIZ. GAIN, and note that the dot will expand to a line across the face of the tube. This is the horizontal sweep, and the line will return to a dot if the coarse frequency is turned to EXT. position. This is because in this position the internal sweep oscillator is turned off, and the horizontal amplifier is conected directly to the HORIZ. INPUT binding post. Any signal applied to the HORIZ. INPUT binding post will cause the line to lengthen horizontally in the proportion to the peak value of the applied signal.

   J. With the COARSE FREQUENCY control still in the EXT. position, apply a 25 volt ac signal to the VERT. INPUT binding post (it can be taken from the 25 v. terminal on the rear panel). Turn the HORIZ. GAIN control to 0, and slowly increase the VERT. GAIN. The dot will now expand into a vertical line, which is the trace of the electron beam caused by the alternating voltage applied to the vertical deflecting plates of the cathode ray tube, through the vertical amplifier. The height of this line is proportional to the peak value of the voltage applied.

   K. Return the COARSE FREQUENCY control to the 70/385 position, and slowly increase the horizontal gain, until the total trace width is about four or five inches. By careful adjustment of the FREQ. VERNIER, and the SYNC. SIGNAL control, a stationary sine wave pattern can be obtained, showing the wave form of the 25 volt signal applied to the vertical amplifier. It is best procedure to adjust the FREQ. VERNIER with the SYNC. SIGNAL at 0, until the pattern is as stationary as possible, then use only as much sync signal as necessary. The SYNC. SIGNAL control operates in a phase-inversion circuit, so that signals of either positive or negative polarity

may be used to synchronize the internal sweep oscillator.

L. Rotate the FREQ. VERNIER to obtain patterns containing up to 6 cycles of the sine wave. This indicates the manner in which a convenient number of cycles of the voltage under examination may be displayed.

M. Set the COARSE FREQUENCY to 60 CYCLE SWEEP, and the INTENSITY control to *minimum*. Connect the VERT. INPUT to the 25 volt ac terminal on the rear panel, through a small condenser of about .0003 mf capacity. and connect a 50,000 ohm resistor between the VERT. INPUT terminal and ground. From an audio oscillator, apply a signal of about 15 volts. at 300 cycles to the INTEN. MOD. terminal, and slowly increase the intensity until a broken line ellipse is seen on the screen. Adjust the frequency of the audio oscillator carefully, until the broken lines stand still, and note that there are 5 such lines. This indicates the ratio between the frequency applied to the deflecting plates and the frequency applied to the intensity modulation terminal.

CAUTION: In any application where a signal is applied to the INTENSITY MOD. terminal, start with the INTENSITY control at minimum, and increase slowly until the desired brilliance is obtained.

2. Summary of Control Functions.

A. INTENSITY. Varies the brightness of the image, by changing the bias on the cathode ray tube.

B. FOCUS. Controls the width of the image-forming electron beam by varying the potential applied to the focussing electrode of the cathode ray tube.

C. VERT. POSITION. Moves the center line (zero voltage position) of the image up or down by applying fixed potential differences between the vertical deflecting plates.

D. HORIZ. POSITION. Moves the sweep center line (zero sweep position) to the left or right by applying fixed potential differences between the horizontal deflecting plates.

E. SYNC. SELECTOR. Provides for synchronization of the sweep oscillator with either an external signal (EXT. position); with a sixty cycle sine wave signal provided internally (60 CYCLE position); or with the signal applied to the VERT. INPUT connector (INT. position).

F. 60 CYCLE PHASING. Varies the positions of the two traces obtained when using 60 CYCLE SWEEP, by correcting the phase relation between the signal generator sweep and the oscilloscope sweep. This control is effective only when the COARSE FREQUENCY selector is turned to the 60 CYCLE SWEEP position.

G. FREQ. VERNIER. Varies smoothly the frequency of the sweep oscillator between the limits set by the position of the COARSE FREQUENCY control.

H. VERT. GAIN. Expands the image in a vertical direction by varying the output of the cathode follower.

I. SYNC. SIGNAL. Stabilizes the trace. Provides for application of a synchronizing voltage of the proper polarity to the horizontal sweep oscillator, regardless of the polarity of the impulse fed in through the EXT. SYNC. binding post. The polarity and amplitude of the sync signal applied is determined by the position of this control. Usually better stability can be obtained on one side of the 0 than on the other, depending on the type of synchronizing signal used.

J. HORIZ. GAIN. Expands the image in a horizontal direction by varying the output of the cathode follower. Note that this control does not vary the portion of the signal at the HORIZ. INPUT terminal, which is applied to the cathode follower. It is "wide open" all the time, and will overload if more than 25 volts rms is applied, regardless of the setting of the HORIZ. GAIN control. As full horizontal deflection (twice screen diameter) is obtained from about 7 volts input, application of higher voltages is unnecessary.

K. VERT. ATTENUATION. Reduces the height of the vertical trace by attenuating the signal fed from the VERT. INPUT terminal to the cathode follower. The 1:1 position applies full signal; the 10:1 applies 1/10th of the signal, etc.

L. COARSE FREQUENCY. Sets the frequency range on the horizontal sweep oscillator within which the FREQ. VERNIER operates. The range is indicated by the numbers on either side of the mark to which the COARSE FREQUENCY switch is set. For example, if it is set to the line between the figures 70 and 385, the FREQ. VERNIER will vary the sweep rate between 70 and 385 cycles per second.

1. There are two special positions on this switch. The EXT. position turns off the sweep oscillator and connects the horizontal amplifier direct to the HORIZ. INPUT binding post. The 60 CYCLE SWEEP position turns off the sweep oscillator, and applies a 60 cycle sine wave voltage to the horizontal amplifier. When turned to the 60 CYCLE SWEEP position, the 60 CYCLE PHASING control is in the circuit.

M. VERT. DEFLECTION PLATES (A switch on the *rear* panel). Provides choice of direct input to the vertical deflection plates on the cathode ray tube (jacks D3 and D4), or though the vertical amplifier (VERT. INPUT binding post on *front* panel). Note that jacks D3 and D4 are connected directly to the geometrically corresponding deflection plates when this switch is in the DIRECT position.

N. HOR. DEFLECTION PLATES (A switch on the *rear* panel). Provides choice of direct input to the vertical deflection plates on the cathode ray tube to the horizontal deflection plates on the cathode ray tube (jacks D1 and D2), or through the horizontal amplifier (HORIZ. INPUT binding post on *front* panel). Note that jacks D1 and D2 are connected directly to the geometrically corresponding deflection plates when this switch is in the DIRECT position.

## APPLICATIONS

Efficient application of the Type 400 Television Oscilloscope is dependent upon the user being acquainted with characteristics and limitations which are described below. Properly used, this instrument will be found to be highly effective in the study and servicing of all types of electrical and electronic equipment, including television and radio receivers, television and radio transmitters, amateur and police transmitters and receivers, and industrial and laboratory equipment.

1. *Line Voltage and Frequency.* The Sylvania Type 400 Television Osciloscope is designed to operate on an a-c power line with the nominal voltage of 117 volts and a frequency of 50 or 60 cycles.

2. *Safety Glass Shield and Graph Mask.* The face of the 7-inch cathode ray tube is protected by a safety glass shield one-eighth of an inch thick. A graph mask is placed on the inside surface to minimize the adverse effects of parallax. The inside surface of the rubber visor has been made parallel, rather than tapered, so that a paper light shield can be used if desired.

3. *Sensitivity.* The high maximum sensitivity of 10 millivolts rms per inch of deflection sometimes causes unwanted pickup from extraneous fields when an unshielded high impedance lead is used with full gain setting. The vertical deflection amplifier has a maximum gain of approximately 2500 and, therefore, the VERT. INPUT terminal itself may pick up noticable interference from stray a-c fields in the vicinity of the instrument.

   In the accurate measurement of rapidly rising pulses, it is advisable to terminate the vertical input leads as shown in Fig. 3. This reduces the sensitivity of the oscilloscope by a factor of about 10 but it also reduces the capacitance in proportion.

4. *Intensity Modulation.* The control grid voltage of the cathode ray tube is varied by the application of intensity modulation. The purpose is to cause the extinction of the screen pattern in accordance with the negative components of an applied pulsing voltage and to intensify the trace on positive components. It is important to note that the *peak* voltage on the control grid, with respect to the cathode, should at no time be more positive than plus 2 volts. The maximum safe voltage which can be applied to the intensity modulation *terminal,* however, depends upon the setting of the intensity control. When the intensity control is set for maximum brilliance of the pattern, the control grid bias voltage is zero volts, and the applied positive intensity modulation voltage should not exceed 2 volts *peak.* It is strongly recommended that before any intensity modulation voltage is connected to the Type 400 Oscilloscope, the INTENSITY control be turned to its minimum position

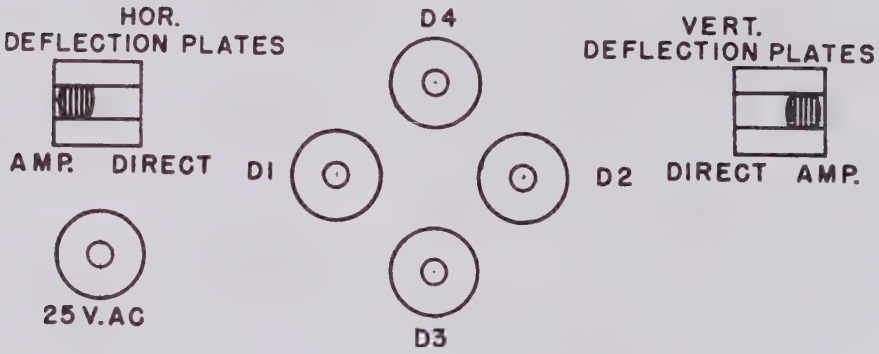



Fig. 2—Outline of the rear panel showing the location of the terminals for direct application of signal voltages to the deflection plate of the cathode-ray tube and the switches for disconnecting the deflection amplifiers.

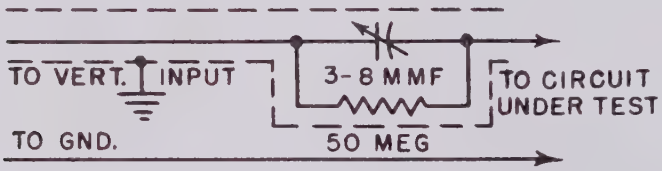



Fig. 3—Input lead termination recommended for accurate observation of pulses. The capacitance should be adjusted to be equal to about 10% of the combined capacitance of the lead and the input capacitance of the vertical amplifier.

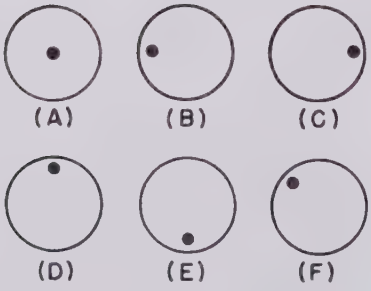



Fig. 4—Deflection of the cathode-ray beam caused by the application of d-c voltages directly to the deflection plates. The no-voltage position of the luminous spot is shown at (a). The deflections caused by voltages of opposite polarity on the horizontal plates are shown at (b) and (c), and for the vertical plates at (d) and (e). The effect of d-c voltage on both sets of plates is shown at (f).

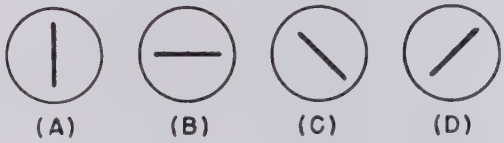



Fig. 5—A straight line pattern results as the cathode-ray beam swings back and forth under the influence of an a-c voltage. A vertical or horizontal line results when the voltage is applied to the vertical (a) or horizontal (b) deflection plates. A diagonal line results when an a-c voltage is applied to both vertical and horizontal plates, either in phase of 180° out of phase (c) or (d).

to avoid accidental damage to the cathode ray tube. The INTENSITY control can be turned slowly to the desired position after connecting the intensity modulation voltage. Peak positive voltage should not exceed 70 volts even with the INTENSITY control at minimum, nor should the peak negative voltage ever exceed 200 volts.

5. *Horizontal Input Voltage.* The voltage applied to the horizontal input terminal should not exceed 25 volts rms sine wave (35 volts peak). The reason is that the input terminal is connected directly to the grid of the first horizontal amplifier tube, with the horizontal gain control located *after* this tube. Excessive voltage will cause overloading of the horizontal amplifier, with resultant linear distortion of the trace.

6. *Vertical Input Voltage.* The voltage applied to the VERT. INPUT terminals should not exceed 700 volts rms (1000 volts peak) or 600 volts dc. A step attenuator in the highest setting (1000:1 is high and 1:1 is low) consistent with ample size of pattern higher input voltages may be applied without overloading the amplifier. It is suggested that the VERT. GAIN control be set at about half scale and the VERT. ATTENUATION control turned to obtain approximately the desired vertical deflection. The VERT. GAIN control can be used then to adjust the deflection to the desired amount. Care must be exercised not to cause distortion in the shape of the curve by overloading the oscilloscope amplifiers.

7. *Frequencies higher than 2 megacycles.* The response of the Sylvania Television Oscilloscope, Type 400, is approximately 6 db down at 3 megacycles, and 12 db down at 4 megacycles.

8. *Frequencies below 10 cycles.* The response below 10 cycles is useful, and the time constant of the amplifier circuit is fast enough to permit the pattern to come to rest quickly with relatively little bouncing.

9. *Voltage, Current, and Frequency Measurement.*

   A. *Measurement.* The positions of the luminous dot shown in Fig. 4 indicate how the spot is deflected away from its at-rest center position to various locations on the screen by applying d-c voltages directly to the deflecting plates. The patterns in Fig. 5 show the straight-line traces obtained when the spot swings rapidly back and forth under the influence of alternating voltages applied in various ways to the deflecting plates. These patterns are obtained with the horizontal linear sweep oscillator switched off. The electrostatic deflection cathode ray tube is a voltage-operated device, since deflection of its electron beam is accomplished by setting up potential differences on parallel plates, between which the beam passes. Both horizontal and vertical deflection are proportional to the instantaneous values of applied horizontal and vertical signal voltages. These voltage values may be determined by measuring the length of the traces they produce, provided the viewing screen is calibrated.

   D-C voltages are measured by direct application of the unknown voltage to the deflection plates of the cathode ray tube. The reason for this is that the amplifiers and series capacitors will not pass the d-c. Either the vertical or horizontal deflection plates may be used. The oscilloscope is calibrated by the application of a known voltage to the selected pair of plates and noting the deflection of the spot. As the deflection varies linearly with the voltage only one calibration is necessary for each setting of the gain controls, but an additional check point may be desirable.

   When an alternating voltage is applied to the vertical deflecting plates, the spot is shifted vertically up and down from the center of the screen by the positive and negative half-cycles, respectively. When the same value of alternating voltage is applied to the vertical plates and a linear sweep voltage is applied to the horizontal deflecting plates, the pattern on the screen takes the shape of the voltage applied to the vertical plates when the sweep frequency is adjusted to an integral multiple of its frequency. This pattern is shown in Fig. 6. The trace shows not only positive and negative peak voltages values, but the waveform as well. Additional information gained from a study of the pattern includes, (1) whether the positive and negative peaks are of the same amplitude, (2) whether the voltage is a true sine wave or whether it is distorted, and (3) whether the voltage under study has constant frequency.

   Voltage relations of the sine wave traces are illustrated by Fig. 7. The height, measured

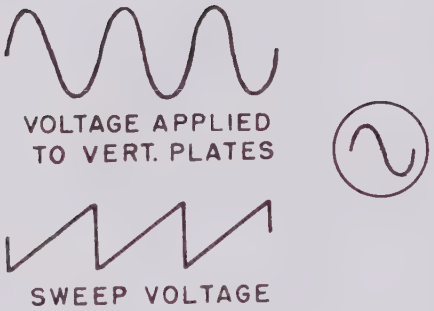



Fig. 6—The voltage waveform produced when the saw-tooth sweep voltage is applied to the horizontal plates, and an a-c voltage to the vertical plates.

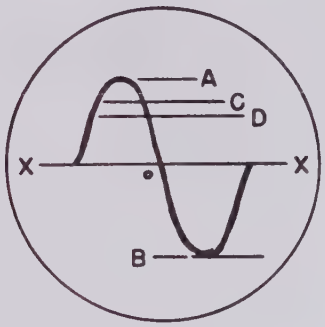



Fig 7—Voltage relations of the sine wave. The zero base line is xx. The positive peak value is at A, the negative peak value at B, the rms value at C and the average value at D.

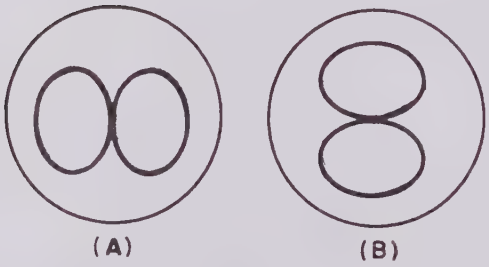



Fig. 8—Lissajous figures for a frequency ratio of 2 to 1. In (a) the higher frequency is applied to the vertical plates and in (b) to the hoizontal plates.

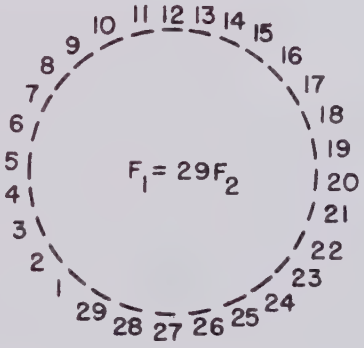



Fig. 10—A typical pattern for determining frequency of an unknown signal by the spot wheel method using intensity modulation.

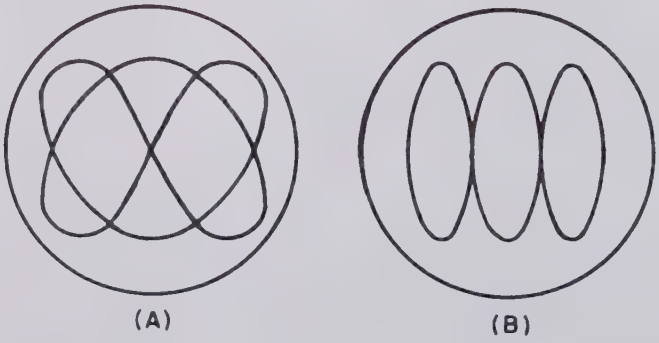



Fig. 9—Lissajous figures for the frequency ratios of 3 to 2 (a) and 3 to 1 (b).

from the center of the screen to the upper tip of the image, indicates the peak voltage of the positive half-cycle. This is the distance OA. Similarly, OB (the distance measured down from center to the lower tip of the pattern) indicates the peak voltage of the negative half-cycle. For a sine wave, distance OC is 70.7% of the upper half, and, therefore, indicates the effective or rms voltage of the positive half-cycle, while distance OD is 70.0% of the lower half and indicates the rms voltage of the negative half-cycle. These points are sometimes referred to as "half-power" points. Distance AB, from one tip of the pattern to the other, indicates the peak-to-peak voltage A point 63.6% of the highest peak above or below center would indicate the average voltage of the sine wave half-cycle.

B. *Current Measurement.* The current in any circuit may be observed by inserting a resistance of very low value in series with the circuit under test and connecting the VERT. INPUT terminals across it. Because the voltage across a pure resistance and the current through it are exactly in phase with each other, the curve of voltage appearing on the screen of the oscilloscope represents a true curve of current through the resistance. The resistance must be as small as possible, so as not to interfere with the operation of the circuit, and yet give sufficient voltage drop to produce a convenient pattern size on the oscilloscope screen. If the voltage calibration of the oscilloscope and the value of the resistance both are known, the value of the current can be computed by use of Ohm's law.

C. *Frequency Measurements.* Frequency measurements are made by comparing any unknown frequency with any known frequency. If two sine waves of the same frequency are applied to the vertical and horizontal inputs of the oscilloscope, a straight line will appear on the screen if they are in phase or are 180° out of phase with each other, as shown in Fig. 5 (c) and (d).

If the two voltages are at different frequencies, a pattern known as a Lissajous Figure will be produced on the screen. For various ratios of the two frequencies definite patterns are produced. For a ratio of 2 to 1 the pattern is as shown in Fig. 8. The patterns for the ratios of 3 to 2 and 2 to 1 are shown in Figs. 9 (a) and (b). The formula for determining the frequency ratio from inspection of the pattern is based upon the number of times the curve of the pattern touches a hypothetical horizontal line at the bottom of the pattern and the number of times it touches another hypothetical vertical line at the one side of the pattern. The formula is shown below:

$$\frac{\text{Number of times the curve touches line at side of pattern}}{\text{Number of times the curve touches line at bottom of pattern}} = \frac{\text{Horizontal Frequency}}{\text{Vertical Frequency}}$$

This method is very useful for determining the frequency of an unknown signal when another signal, whose exact frequency is known, is available. Care must be exercised not to have an excessive number of points to count. It may be desirable sometimes to increase the frequency of the reference signal to reduce the number of points.

10. *Frequency Checking using Intensity Modulation.* A variation of the system for comparing frequencies is is the spot-wheel method. In this system, a spotted-wheel pattern is obtained, as shown in Fig. 10.

The apparatus set up for the spot-wheel method is shown in Fig. 11. The internal sweep oscillator of the oscilloscope is switched off. The oscilloscope must have provision for intensity modulation of the electron beam. The Sylvania Oscilloscope, Type 400, has this feature. With this set-up, a circle or ellipse appears on the screen when no unknown signal is applied. When the unknown signal is applied, the circle or ellipse is broken up into spots or short lines depending upon the wave-form of the unknown signal. To determine the unknown frequency, multiply the oscillator frequency by the number of spots or lines counted around the wheel circumference. If the number of spots or line is too large for accurate counting, or if it becomes difficult to "lock" the wheel pattern, increase the oscillator frequency to obtain a lesser number. The minimum intensity should be used in this application in order to emphasize the spots and blanked-out segments. It is very important that the unknown frequency voltage applied to the Z axis should not exceed a maximum positive peak voltage of 2 volts when the intensity control is at maximum, or 70 volts positive peak when the intensity control is at minimum.

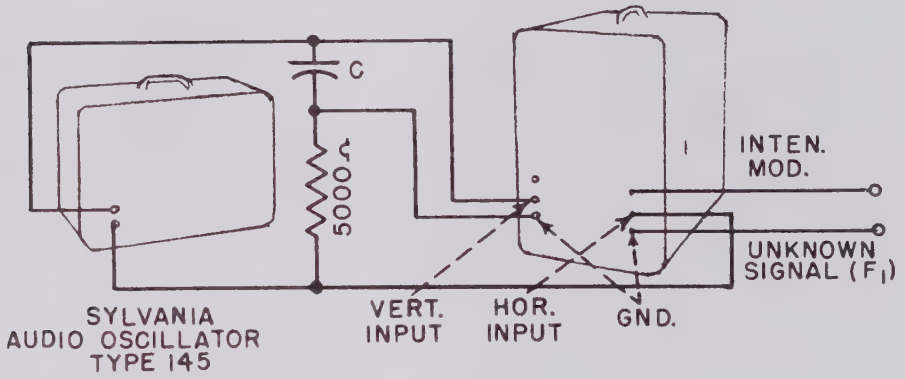



Fig. 11—Instrument connections for determining frequency, using the spot wheel pattern with intesity modulation. ($C = \frac{318}{f}$, for a circle).

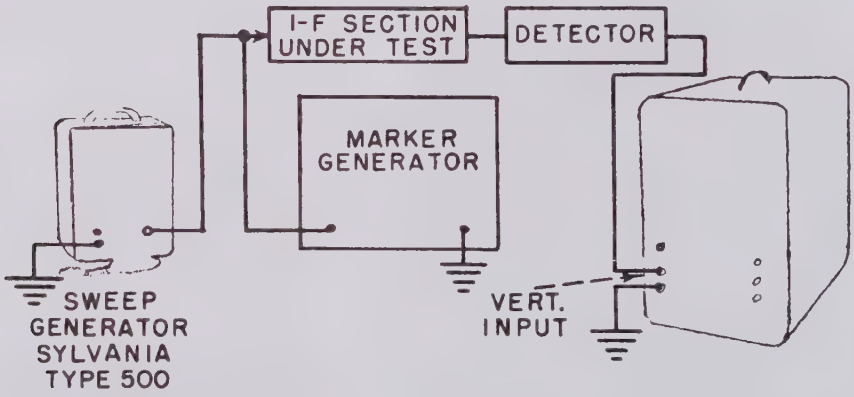



Fig. 12—Instrument connections for observing the response curve of a video i-f amplifier.

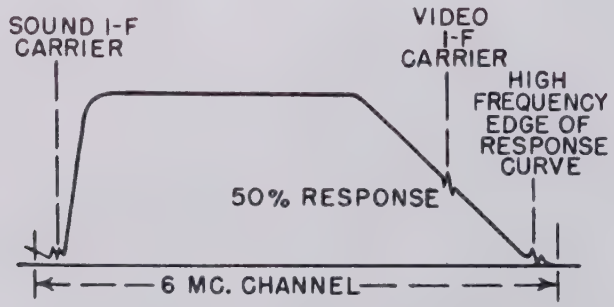



Fig. 13—Standard video i-f response curve produced by the instrument set-up shown in Fig.12. The marker pips are shown for the video and sound i-f frequencies and the high-frequency edge of the channel.

11. *Television Receiver Servicing.* The oscilloscope is indispensible in the servicing of television receivers. It not only saves time, but it makes many service operations possible. It is very often used in conjunction with other test instruments such as sweep signal generators and marker generators.

The discussion given here of the applications of the Sylvania Television Oscilloscope Type 400 in the servicing of television receivers must necessarily be very general. Television circuits are complex in their design and operation and there are many manufacturers in the field. While the basic of all may be the same, the details of each receiver may be different and it is for this reason that the serviceman should refer to the manufacturers service notes for detailed information and instructions for a particular receiver.

A. *Video I-F Stages.* The instruments required for the alignment of the video i-f stages are an oscilloscope (Sylvania Type 400), sweep signal generator (Sylvania Type 500), and a marker generator or an accurately calibrated signal generator covering the video i-f range, (Sylvania Type 216) to be used as a marker generator.

There are two main types of i-f circuits to be discussed here. In the first, the sound portion of the signal is removed from the video portion just ahead of the i-f stages, and in the second, known as the inter-carrier sound type, the sound is taken off after the video detector and video amplifier. The difference in the procedure for the different types of circuit will be pointed out.

To observe the i-f response curve of a television receiver, an oscilloscope is connected to the video detector circuit as shown in Fig. 12. The 60 cycle square wave response of the oscilloscope must be good, as in the Sylvania Type 400, to avoid distortion of the response curve. The output of the sweep signal generator, set at about the center frequency given by the receiver manufacturer, is first connected to the grid circuit of the last video i-f stage. The signal sweep width should be set at approximately eight to ten megacycles to cover adequately the pass band of the i-f stage and the adjacent sound channel. The GROUND terminals of the Type 400 oscilloscope should be connected to the GROUND terminals of the sweep generator and the coarse frequency control turned to the 60 cycle sine wave position.

The response curve of the video i-f stage will now appear on the screen of the oscilloscope. It will be similar in shape to the curve shown in Fig. 13, for a pass-band i-f amplifier. The oscilloscope controls should be set for a convenient pattern size and the phasing control of the oscilloscope adjusted to make the curve as close as possible to a single curve conformation. Due to the fact that both oscilloscope and signal generator sweep voltage are taken inductively from the a-c line, it may sometimes be desirable to reverse the line-cord plug in *one* of the two instruments, to make the response curves come together.

In stagger-tuned circuits the marker generator should be set to the frequency of the last stage in accordance with the manufacturers service notes and the output lead loosely coupled to the same point in the receiver circuit where the sweep generator is connected. This will produce a "pip" in the response curve on the screen. If the pip does not appear where designated by the receiver manufacturer, the trimmer or tuning slug on the last i-f stage should be adjusted until it does.

In the band-pass circuits, the marker generator should be set to the frequencies indicated by the receiver manufacturer, and the curve fitted to the correct marker pips by adjustments of the i-f trimmers or tuning slugs, in accordance with the instructions in the service notes for the particular receiver under test.

The output signals from the sweep generator and the marker generator are now connected to the grid circuit of the preceding video i-f stage and the procedure repeated, using the specified settings for the frequencies of both generators. The amplitude of the output signal of each generator should be adjusted to produce a good pattern on the screen. The adjustments just made on the previous stage should not be disturbed. This procedure should be repeated for each i-f stage until the grid of the converter tube is reached. If the receiver had been badly

out of alignment it may be advisable to repeat the entire procedure in the same order. Be sure also that the sound traps have been adjusted for minimum sound response at the video detector.

In receivers with inter-carrier sound the composite i-f stages are broad enough to pass the entire television video and sound signal, although the sound carrier is considerably attenuated. The sound signal passes through the same amplifier circuits as the video signal, up to a point just before the picture tube. At this point, the sound signal appears as a frequency modulated beat between the video and the sound carriers. The sound signal is trapped off here and fed to the sound channel for further amplification. The alignment procedure is in general the same as described above. A noticeable marker pip should be obtainable for the sound carrier intermediate frequency and a strong one for the video intermediate frequency. Note that in the video i-f stages the adjacent sound carrier would be *above* the video carrier in frequency, due to the inversion of the pattern in the converter stage.

B. *R-F Stages.* The first step is to connect the oscilloscope to the output of the video detector, as was done for the alignment of the video i-f stages. The sweep signal generator is connected to the antenna terminals with its output frequency set approximately to the mid-point frequency of the channel to be aligned. Each channel is aligned individually. The output level of the sweep signal generator is set to produce a good response curve on the screen of the oscilloscope, but not high enough to overload the receiver circuits. Avoid "square-topping" caused by receiver or oscilloscope overloading.

The curve on the screen is a composite curve for the r-f and i-f stages, and it is important to have the i-f stages correctly aligned before any judgment can be made of the r-f stages. If the curve is degraded from the curve obtained for the i-f stages, the r-f tuning should be readjusted for the best shape. The check of r-f alignment should be repeated for each of the channels.

To obtain the response curve of the r-f stage alone, the oscilloscope may be connected through a demodulator probe to the grid circuit of the mixer stage, or directly across the lower half of the mixer grid resistor, if this resistance is in two sections. When the response curve is observed directly in the r-f stage the video carrier frequency will be at the low frequency side of the curve and the sound carrier at the high frequency side. The service notes of the receiver manufacturer should be consulted for specific instructions for the correct procedure for obtaining the r-f stage response curves.

The response curve of an amplifier stage should be of a smooth configuration through all of its bandwidth. If oscillation is present, the curve will lose the smooth outline and will become jagged because of the interference of the oscillating voltage. For the elimination of this condition the manufacturer's service notes should be consulted for specific instructions. However, the cause may be found to be in poor bypassing of the cathode, screen, or plate circuits, poor or no shielding, improper voltages, or poor grounding.

C. *Trouble Shooting by Waveform Analysis.* The Sylvania Type 400 Oscilloscope is very useful in the observation of the many voltage and current wave forms in the various portions of a television receiver circuit. At each point in the circuit there is a definite wave form required for good operation. With a knowledge of what these wave forms should be, and the proper use of the oscilloscope, much time can be saved in the servicing of television receivers. The waveforms shown in the accompanying photographs were obtained with the VERT. INPUT terminals of the oscilloscope connected to the receiver circuit as indicated for each photograph, and the horizontal sweep set to an appropriate frequency. They are typical of what can be produced on the screen of the Type 400 Oscilloscope. Proficiency in obtaining curves will develop rapidly with experience in the use of the oscilloscope in servicing television receivers.

For the video and horizontal deflection waveforms, the oscilloscope sweep frequency used is 7875 cycles and for the vertical deflection waveforms, the sweep frequency is 30 cycles. By using these sweep frequencies, two cycles of the desired waveform are produced on the oscillo-

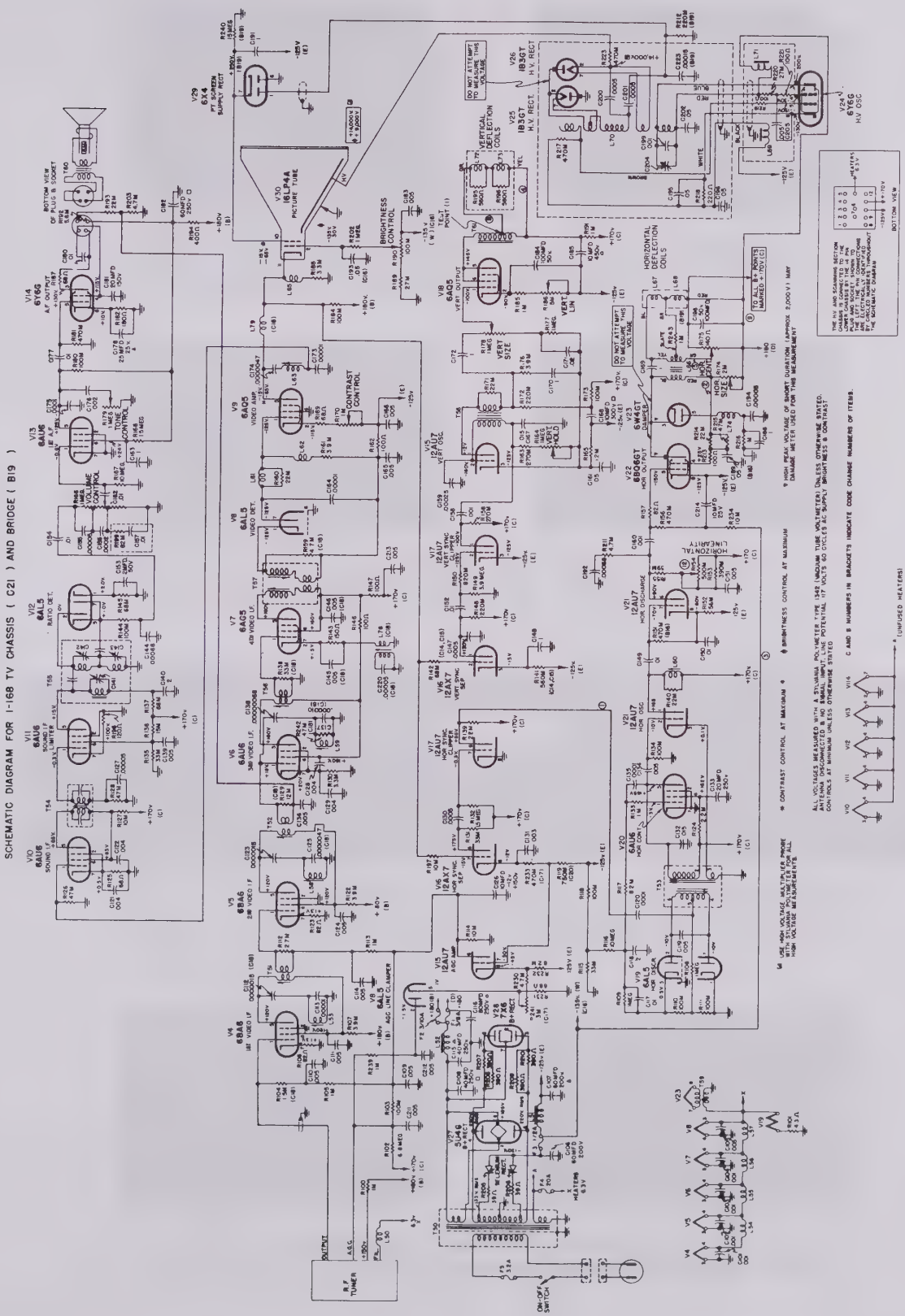

SCHEMATIC DIAGRAM FOR 1-168 TV CHASSIS ( C2I ) AND BRIDGE ( B19 )
V30 19LP4A PICTURE TUBE
BRIGHTNESS CONTROL
CONTRAST CONTROL
VERTICAL DEFLECTION COILS
HORIZONTAL DEFLECTION COILS
R.F. TUNER
ON-OFF SWITCH
HORIZONTAL LINEARITY
TO ALL B+ POINTS MARKED (C)
* CONTRAST CONTROL AT MAXIMUM
♦ BRIGHTNESS CONTROL AT MAXIMUM
ALL VOLTAGES MEASURED WITH A SYLVANIA POLYMETER TYPE 1349 UNIQUAM TUBE VOLTMETER UNLESS OTHERWISE STATED. ANTENNA DISCONNECTED & NO SIGNAL INPUT. LINE POTENTIAL 117 VOLTS 60 CYCLES AC SUPPLY. BRIGHTNESS & CONTRAST CONTROLS AT MAXIMUM UNLESS OTHERWISE STATED
C AND B NUMBERS IN BRACKETS INDICATE CODE CHANGE NUMBERS OF ITEMS.
BOTTOM VIEW

Fig. 14—Circuit diagram of the Sylvania Model 1-090 (Chassis 1-168) television receiver. The photographs of the waveforms on the following pages were made using this receiver.

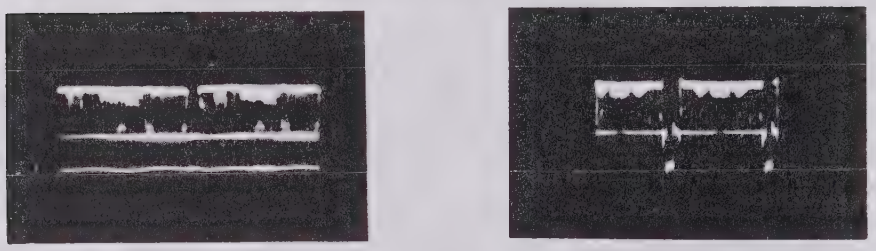


Fig. 15—Video signal at control grid of video amplifier. Sweep frequency on the left is 30 cycles and on the right, 7875 cycles. Peak-to-peak voltage is dependent upon degree of modulation of transmitted signal and in this case is 13 volts for about 90% modulation. Contrast control is at maximum and brightness control at minimum.

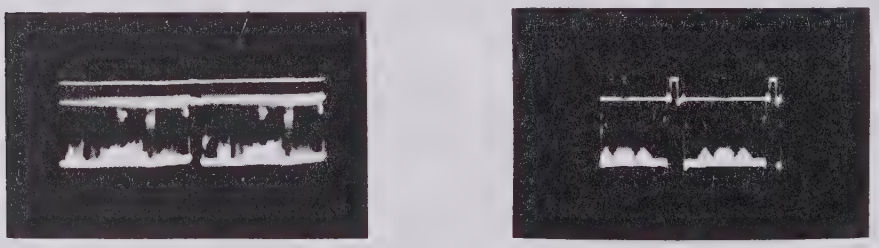


Fig. 16—Video signal at plate of video amplifier. Sweep frequency is 30 cycles on left and 7875 cycles on right. With contrast control at maximum, the peak-to-peak voltage is approximately 77 volts. With contrast control as minimum, it should be approximately 17 volts. Brightness control at minimum.

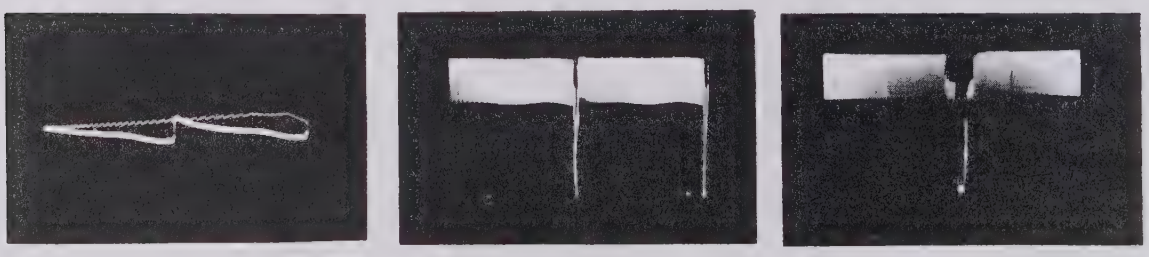


Fig. 17—Left, cathode of vertical sync separator with 30-cycle sweep, peak-to-peak voltage approximately 0.55 volt. Center, plate of vertical sync separator with 30-cycle sweep, approximately 85 volts peak-to-peak. Right, same as center except 60-cycle sine wave sweep. Waveform for one field rather than for two fields as with 30-cycle sweep.

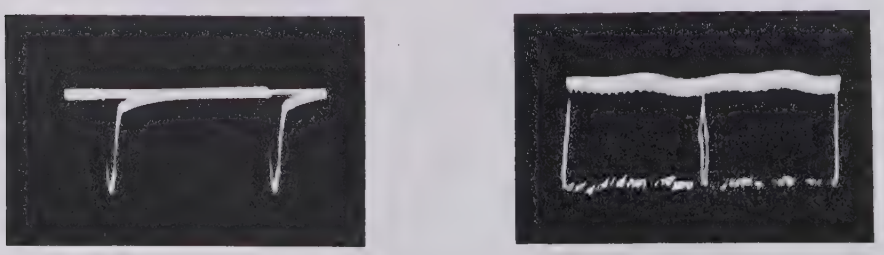


Fig. 18—Plate of horizontal sync separator with a 7875-cycle sweep (left) and a 30-cycle sweep (right), approximately 13 volts peak-to-peak.

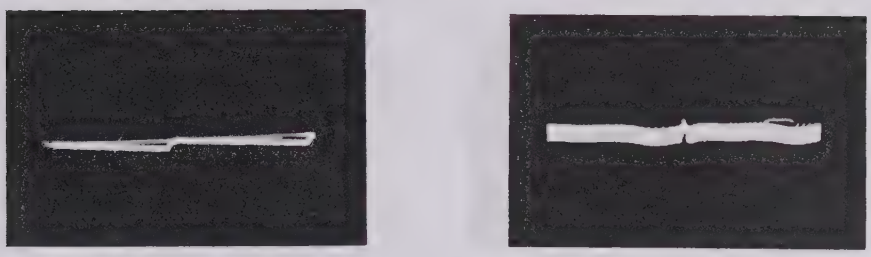


Fig. 19—Cathode of horizontal sync separator with a 7875-cycle sweep (left) and a 30-cycle sweep (right), approximately 2 volts peak-to-peak.

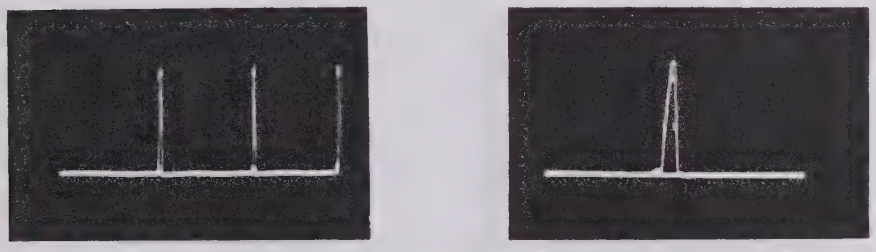


Fig. 20—Plate of vertical sync clipper with a 30-cycle sweep (left) and a 60-cycle sine wave sweep (right), approximately 2 volts peak-to-peak.

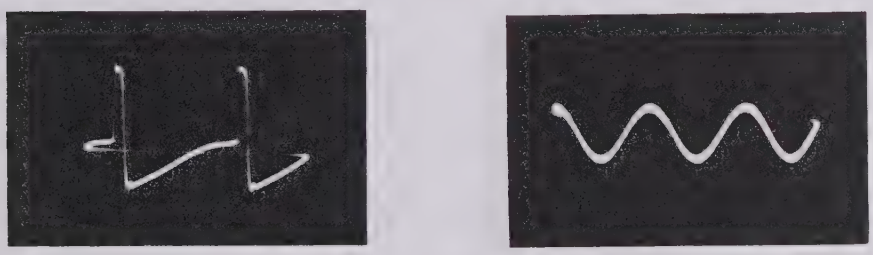


Fig. 21—Left, plate of horizontal discriminator, sweep frequency of 7875 cycles, 55 volts peak-to-peak. Right, plate to plate of horizontal discriminator (double diode) with sweep frequency of 7875 cycles, 12 volts peak-to-peak.

Fig. 22—Left, control grid of vertical oscillator, 30-cycle sweep, 240 volts peak-to-peak. Right, plate of vertical oscillator, 30-cycle sweep, 135 volts peak-to-peak.

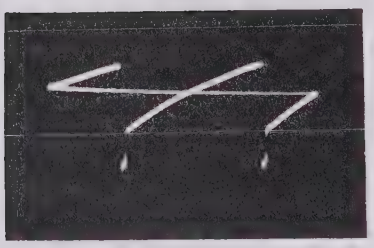
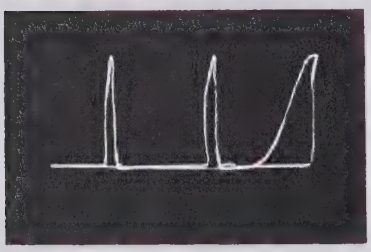


Fig. 23—Left, control grid of vertical output tube, 30-cycle sweep, 135 volts peak-to-peak.) Right, plate of vertical output tube, 30-cycle sweep, 700 volts peak-to-peak.



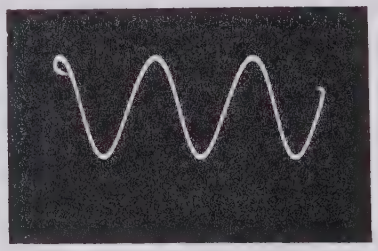


Fig. 24—Left, plate of horizontal sync clipper 7875-cycle sweep, 80 volts peak-to-peak.) Right, plate of horizontal control tube, 7875-cycle sweep, 40 volts peak-to-peak.

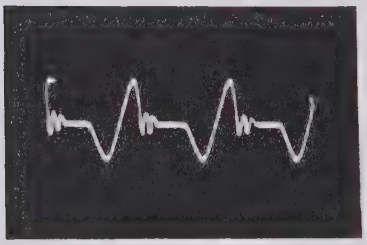


Fig. 25—Left, plate of horizontal oscillator, 7875-cycle sweep, 40 volts peak-to-peak. Right, plate of horizontal discharge tube, 7875-cycle sweep, 105 volts peak-to-peak.

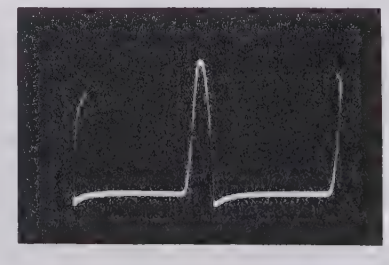


Fig. 26—Left, high side of vertical deflection coil to ground, 30-cycle sweep, 70 volts peak-to-peak. Right, plate of horizontal output tube, 7875-cycle sweep, 1500 to 3000 volts peak-to-peak depending on design of circuit.

scope screen. The horizontal sweep direction is from left to right, and the vertical deflection corresponds to positive polarity. All waveforms are measured with respect to ground unless otherwise specified. Any serious variation from the waveforms shown here indicates that some portion of the circuit is functioning improperly due to a defective or improperly adjusted component, or as a result of poor mechanical positioning of some component or lead wire. For exact information on a particular receiver, the manufacturer's service notes should be consulted.

12. Radio Receiver Servicing.

A. *A M Receivers.* Accurate alignment of AM receivers may be obtained by using the Type 400 Oscilloscope with the VERT. INPUT connected to the voice coil of the loudspeaker. An amplitude modulated signal generator is used to feed a signal into the receiver and the normal procedure of aligning the i-f and the r-f stages is followed. The oscilloscope acts as a peak voltage indicator in this method because the horizontal deflection is not used. The pattern is a vertical straight line.

In the servicing of better quality receivers it may sometimes be desirable to examine the selectivity curves of the various stages. To do this, the VERT. INPUT and GND. terminals are connected across the detector load resistor, and the output of a frequency-modulated signal generator, such as the Sylvania Type 216, is connected to the grid of the last i-f tube. The frequency of the f-m generator output signal is set to the i-f frequency and the sweep set to a value wide enough to cover the audio band of the stage. For top grade receivers this would be of the order of 20 to 30 kc. When the sweeping frequency of the signal generator is 60 cycles, the COARSE FREQUENCY control on the oscilloscope may be turned to 60 CYCLE SWEEP, and no sync connection will be necessary.

The selectivity curve will resemble one of the curves shown in Fig. 27. The trimmers should be adjusted until the curve has the general appearance of Fig. 27.(a) which is neither too broad or too sharp. The signal generator lead is then moved to the grid of the previous i-f tube and the process repeated with the oscilloscope still connected across the detector load resistor. The amplitude of the signal from the generator should be reduced to avoid overloading the stage. The procedure is repeated for each i-f stage until the grid of the mixer tube is reached.

The next operation is to align the r-f section. The frequency of the signal generator and the receiver are both set to 1500 kc. and the trimmers on the r-f and oscillator sections of the tuning condenser are adjusted until a selectivity curve similar to the curve of Fig. 27.(a) appears on the screen. The signal generator and receiver are then set to 600 kc. and the padders of the tuning condenser are adjusted instead of the trimmers. The selectivity curves of the individual stages may be observed by using a detector probe connected to the VERT. INPUT terminals of the oscilloscope. In this way the various stages can be aligned independently of the others, which is sometimes advantageous. To insure a high-frequency pass band, it is necessary to obtain a curve (pattern) with a top as straight and horizontal as possible. The flat top must be obtained without causing too much loss of height, or producing top tilting such as is illustrated by the pattern in Fig. 27.(f).

In the alignment of a high-fidelity receiver, the oscilloscope is connected across the diode load resistor. However, when the receiver employs a power detector instead of the diode type, the vertical input terminal of the oscilloscope must be connected to the plate end of the detector plate load resistor, and the ground terminal of the oscilloscope to chassis ground of the receiver, or to B-minus when the chassis is not at ground potential. The receiver manufacturer's service notes should be consulted for the correct value of bandwidth and for specific instructions on the alignment procedure.

B. *General Alignment Notes.* Many receivers use powdered-iron slugs for inductive tuning and trimming. Visual alignment of such receivers is done in the same way as outlined above, ex-

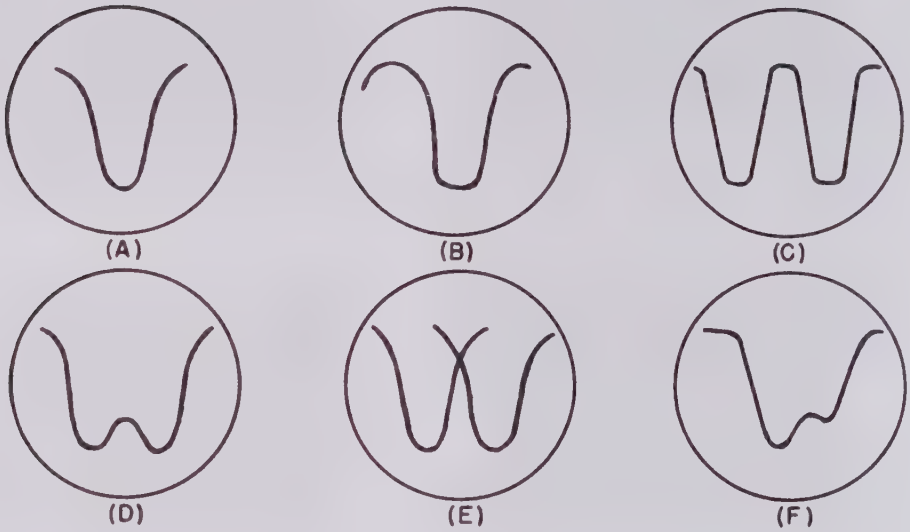



Fig. 27—Selectivity curve of i-f stages obtained using a frequency-modulated signal generator.

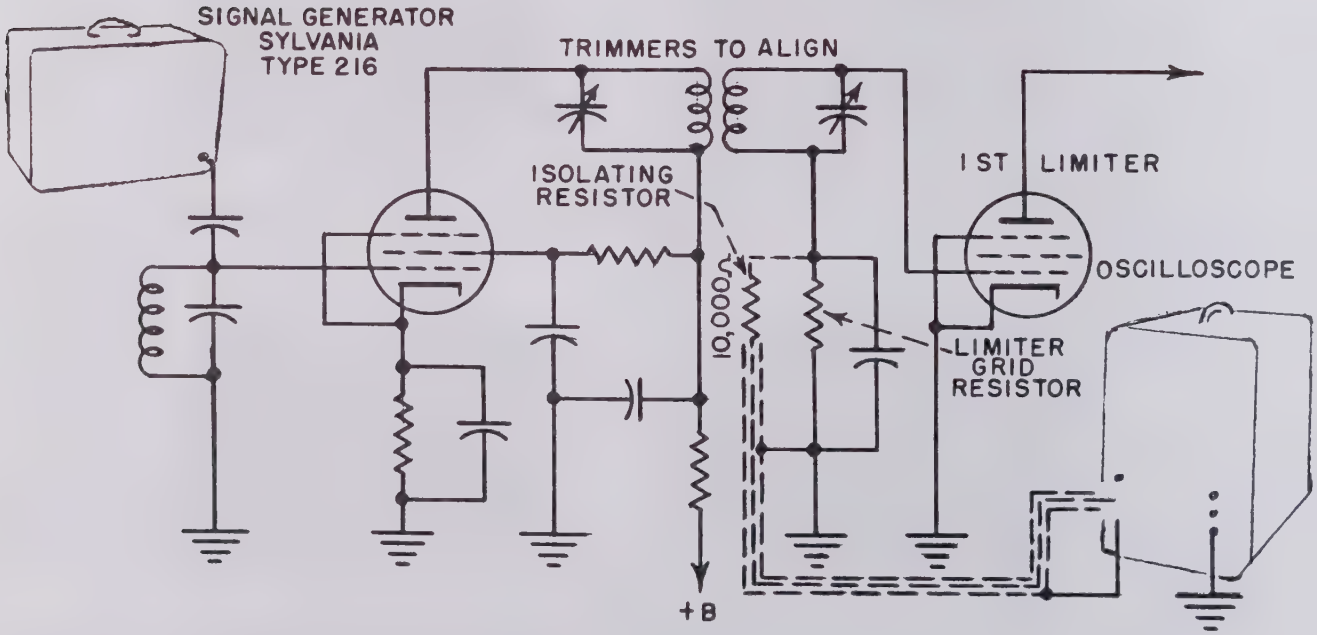



Fig. 28—Oscilloscope connections for i-f amplifier alignment in an F M receiver.

cept that slugs instead of capacitors must be adjusted in the various stages. No special connections, not already covered, need be made. In an all-wave receiver, alignment of the front end of set must be completed for each setting of the band switch. The generator must be set successively to frequencies near the top and bottom of each wave band, just as the frequencies of 1500 and 600 kc. were used for alignment of the broadcast range. Alignment of i-f and 2nd detector stages need be performed only once.

Occasionally the connection of an oscilloscope to a radio receiver results in pickup of outside signals, noise, or hum voltage; or in internal regeneration or oscillation. Either of these conditions will cause modulation or distortion of the pattern on the screen. Usually a short, well-shielded lead to the vertical input terminals will correct the trouble. In stubborn cases, it may be necessary to include a 50,000-to 100,000-ohm series resistor in the vertical input lead as close as practicable to the point of contact in the receiver circuit.

C. *FM Receivers.* An FM receiver is very similar to, and often identical with, an AM superheterodyne receiver from the antenna and ground terminals through the i-f amplifier. The audio stages are the same as in an AM receiver. The point of difference is that the AM receiver utilizes a second detector between the i-f and a-f amplifiers, while the FM receiver uses a discriminator (often preceded by one or more limiter stages) in this same position. More recently-designed FM receivers employ a special type of discriminator, the ratio detector, which requires no limiter stage. Alignment of the FM receiver differs from AM alignment chiefly in the special adjustment of the discriminator or ratio detector.

D. *Discriminator-Type Receiver.* The i-f circuits are aligned by connecting the VERT. INPUT terminal to the high side of the first limiter grid resistor through a short shielded lead as shown in Fig. 28. An isolating resistor of approximately 100,000 ohms is sometimes used at the connection to the circuit. The output of a frequency-modulated signal generator is connected to the grid of the last i-f tube. The frequency of the signal is the same as the intermediate frequency of the receiver and the frequency deviation is set to approximately plus and minus 150 kc. for a total sweep of 300 kc. The receiver manufacturer's service notes should be consulted for the exact value of intermediate frequency. The trimmers of the last i-f stage should be adjusted to obtain a pattern similar to that of Fig. 27.(d). The bandwidth of the i-f amplifier is somewhat broader than it would be in an AM receiver and, therefore, the sharp curve of Fig. 27.(a) will not be satisfactory.

The signal generator output lead is next transferred to the grid of the next previous i-f stage and the trimmers of this stage adjusted until the selectivity curve again matches the curve of Fig. 29.(d). The signal is fed to the grid of each i-f stage until the grid of the converter stage is reached and the procedure repeated for each stage.

For discriminator alignment the VERT. INPUT terminal of the oscilloscope is connected to the top of the discriminator load resistor through a shielded lead as shown in Fig. 29. The signal generator output must remain connected to the signal grid of the converter tube. The sweep frequency of the generator is 60 cycles and the sweep frequency of the oscilloscope is set to 120 cycles. The pattern on the screen will then be similar to the curve shown in Fig. 30.(a). The trimmers of the discriminator transformer must be adjusted to bring points A and C, or E and G, equal distances from the horizontal center line (B or F). Also, the adjustments must be continued to bring B and F equal distances from D. Slant lines AG and CE will intersect, with point D resting on the horizontal line when alignment is correct. Adjustment of the primary trimmer of the discriminator transformer controls the distance of the points A, C, E, and G from the horizontal center line. Adjustment of the secondary trimmer controls the position of the cross-over point D with respect to the horizontal center line and spacing from points B and F.

If the oscilloscope is synchronized at 60 cycles and the signal generator sweep is 60 cycles, the pattern shown in Fig. 30.(b) will be produced on the screen during discriminator alignment. The discriminator transformer trimmers

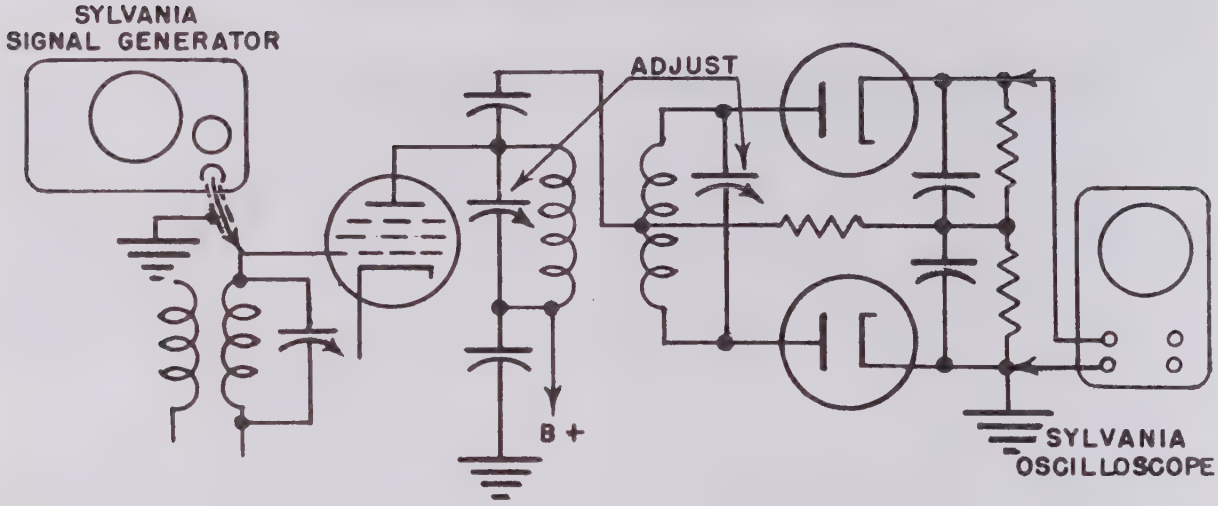



Fig. 29—Oscilloscope connections for discriminator alignment in an F-M receiver.

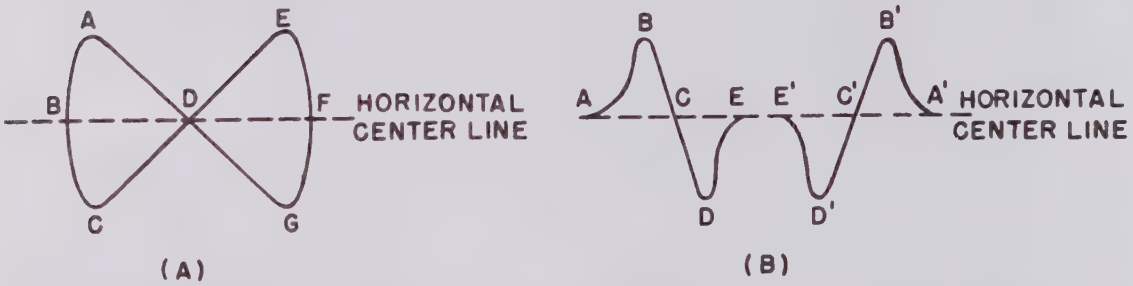



Fig. 30—Alignment pattern for discriminator or ratio detector.) The frequency of the sync voltage is twice the sweep frequency of the F-M signal generator in (a) and equal to it in (b).

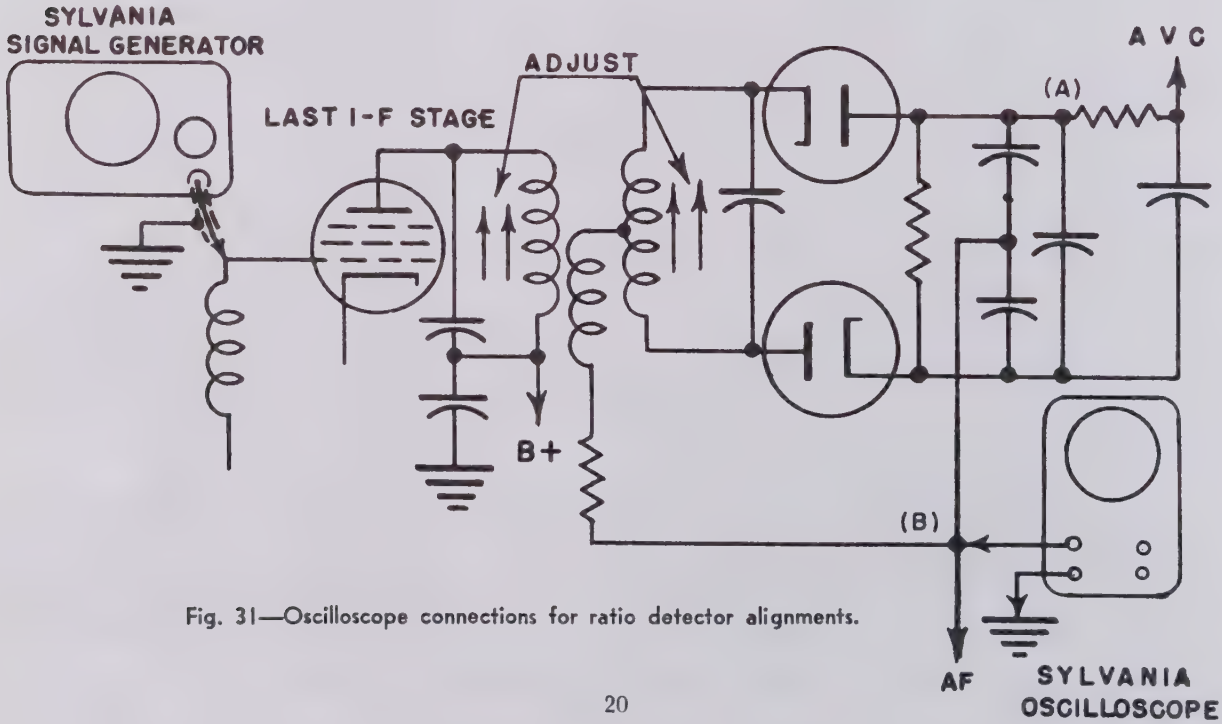



Fig. 31—Oscilloscope connections for ratio detector alignments.

must be adjusted in this case to bring points B and D (or B′ and D′) equal distances from the horizontal centerline, and points A and E equal distances from C, (or A′ and E′ equal distances from C′)

E. *Ratio-Detector Type Receiver.* The i-f amplifier of an FM receiver using a ratio detector is aligned in the same manner as a discriminator type receiver except that the VERT. INPUT terminal of the oscilloscope is connected through a shielded lead to the high side of the detector load resistor as shown in Fig. 31 (A). The i-f amplifier up to and including the primary of the ratio detector transformer may be aligned with this connection.

The secondary of the ratio detector transformer is aligned by transferring the VERT. INPUT shielded lead to point indicated in Fig. 31 (B). The same pattern as for the discriminator alignment, Fig. 30. (A), is double the sweep frequency of the signal generator. The detector trimmers are adjusted in the same manner as for discriminator alignment to obtain the proper symmetry of the pattern. For close alignment of both primary and secondary trimmers it is necessary to work back and forth with the VERT. INPUT terminal connected successively to points A and B of Fig. 31.

Front End Alignment. The front end of an FM receiver (that is, the r-f, converter, mixer, or first detector-oscillator section) resembles that of any other superheterodyne except that it is tuned to the band from 88 to 108 Mc. Alignment is the same as for AM front ends except for the operating frequency.

## SERVICE

For service, carefully pack the COMPLETE equipment with coaxial lead and ship it to your nearest Sylvania Service Station by PREPAID EXPRESS. Accompany it with a letter describing the trouble and giving the PURCHASE DATE.

## AUTHORIZED SYLVANIA SERVICE STATIONS

EAST COAST STATES
Radio Television Company
723 Ponce de Leon Ave., N. E.
ATLANTA, GEORGIA
Attn: Mr. G. F. Johnson

FACTORY SERVICE STATION
Sylvania Electric Products, Inc.
1221 West Third Street
WILLIAMSPORT, PENNSYLVANIA
Att: Mr. J. H. Mintzer

CENTRAL STATES
Master Electric Service
835 West Washington Blvd.
CHICAGO 7, ILLINOIS
Att: Mr. Richard Lomastro

WEST COAST STATES
Service Radio Wholesale
1357 Post Street
SAN FRANCISCO 9, CALIFORNIA
Att: Mr. Jerry Shirek

Ionic Equipment Company
1705 North Kenmore
LOS ANGELES 27, CALIFORNIA
Att: Mr. Eric Swarthe

CANADA
Bayly Engineering, Ltd.
5 First Street
AJAX, ONTARIO, CANADA
Att: Mr. B. DeF. Bayly

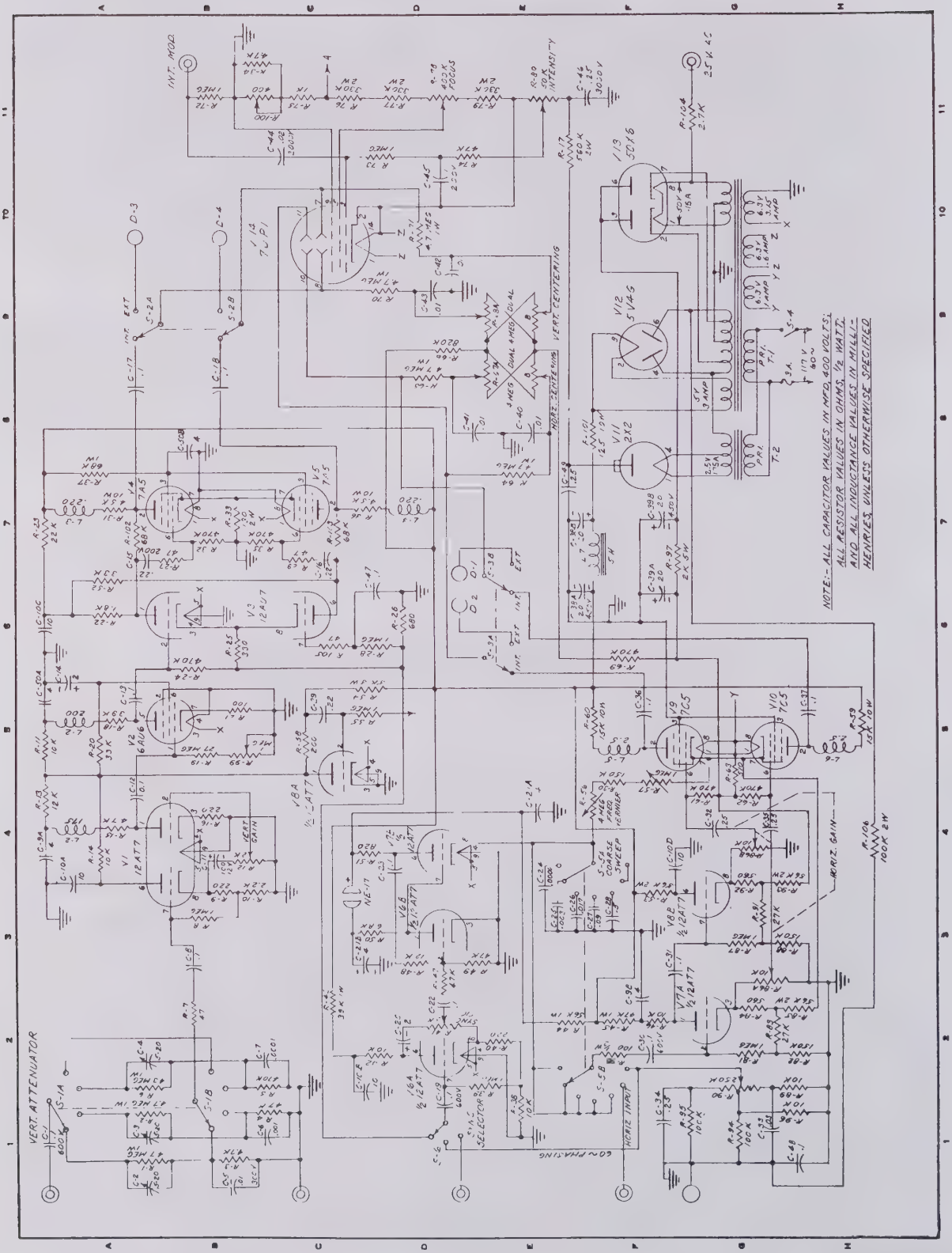

NOTE:- ALL CAPACITOR VALUES IN MFD. 400 VOLTS; ALL RESISTOR VALUES IN OHMS, ½ WATT; AND ALL INDUCTANCE VALUES IN MILLI-HENRIES, UNLESS OTHERWISE SPECIFIED
VERT. ATTENUATOR
HORIZ. GAIN
HORIZ. CENTERING
VERT. CENTERING
SELECTOR
60~ PHASING

Fig. 32—Complete circuit diagram of the Sylvania Television Oscilloscope Type 400.

## PARTS LIST

| Symbol | Description | Rating | Tol. | Sylvania Part No. |
|---|---|---|---|---|
| C-1, 30 | Capacitor, fixed paper | 0.1 mf., 600 V. | +40% —20% | 19079 |
| C-2, 3, 4 | Capacitor, variable mica | 3-30 mf., 500 V. | | 18602 |
| C-5 | Capacitor, fixed mica | 10,000 mmf., 300 V. | ±10% | 18624 |
| C-6 | Capacitor, fixed mica | 1000 mmf., 500 V. | ±10% | 18623 |
| C-7 | Capacitor, fixed mica | 100 mmf., 500 V. | ±10% | 18621 |
| C-8, 22, 23, 48 | Capacitor, fixed paper | 0.1 mf., 400 V. | ±20% | 19055 |
| C-9, 21, 50 | Capacitor, electrolytic | 4-4 mf., 350 V. | | 18432 |
| C-10 | Capacitor, electrolytic | 10-10-10-10 mf., 450 V. | | 18435 |
| C-11 | Capacitor, electrolytic | 100 mmf., 15 V. | | 18461 |
| C-12, C-13 | Capacitor, fixed paper | 0.1 mf., 400 V. | ±20% | 19214 |
| C-14, 20 | Capacitor, electrolytic | 2 mf., 450 V. | | 3951 |
| C-15, 29, 16 | Capacitor, fixed paper | .22 mf., 200 V. | ±20% | 18434 |
| C-17, 18, 36, 37 | Capacitor, fixed paper | 0.1 mf., 400 V. | ±20% | 18866 |
| C-19 | Capacitor, fixed paper | 0.1 mf., 600 V. | +40% —20% | 19239 |
| C-24 | Capacitor, fixed mica | 560 mmf., 500 V. | ±10% | 18622 |
| C-25 | Capacitor, fixed paper | .003 mf., 400 V. | ±10% | 18431 |
| C-26 | Capacitor, fixed paper | .017 mf., 400 V. | ±10% | 18430 |
| C-27 | Capacitor, fixed paper | .09 mf., 400 V. | ±10% | 18429 |
| C-28 | Capacitor, fixed paper | 0.5 mf., 400 V. | ±10% | 19054 |
| C-31, 47 | Capacitor, fixed paper | 0.1 mf., 400 V. | +40% —20% | 19215 |
| C-32, 34, 35 | Capacitor, fixed paper | .25 mf., 400 V. | ±20% | 19049 |
| C-33 | Capacitor, fixed paper | .03 mf., 400 V. | ±20% | 19061 |
| C-38 | Capacitor, electrolytic | 20-20 mf., 450 V. | | 18428 |
| C-39 | Capacitor, electrolytic | 20-20 mf., 450 V. | | 18426 |
| C-40, 41, 42, 43 | Capacitor, fixed paper | .01 mf., 400 V. | +40% —20% | 19068 |
| C-44 | Capacitor, fixed paper | .02 mf., 2000 V. | +40% —20% | 3930 |
| C-45 | Capacitor, fixed paper | 1.0 mf., 200 V. | +40% —20% | 18433 |
| C-46, 49 | Capacitor, fixed paper | .25 mf., 3000 V. | | 18427 |
| J-1, 2, 3, 4 | Connector, female contact | | | 16426 |
| L-1 | Coil, R.F. iron core | .175 mh. | ±5% | 18503 |
| L-2 | Coil, R.F. iron core | .20 mh. | ±5% | 18859 |
| L-3, 4 | Coil, R.F. iron core | .22 mh. | ±5% | 18437 |
| L-5, 6 | Coil, R.F. iron core | 2.5 mh. | ±5% | 18859 |
| L-7 | Choke, Filter | 4.8 henries, 158 ohms, 165 ma. | | 18486 |
| R-1, 2, 64, 65, 70, 71 | Resistor, fixed comp. | 4.7 meg., 1 W. | ±10% | 1349 |
| R-3, 15, 34 | Resistor, fixed comp. | 4700 ohms, ½ W. | ±10% | 968 |
| R-4, 47, 49, 74 | Resistor, fixed comp. | 47,000 ohms, ½ W. | ±10% | 1010 |
| R-5, 24, 32, 35, 61, 62, 69 | Resistor, fixed comp. | 470,000 ohms, ½ W. | ±10% | 1052 |
| R-6 | Resistor, fixed comp. | 4.3 meg., 1 W. | ±5% | 1347 |
| R-7, 27, 29, 105 | Resistor, fixed comp. | 47 ohms, ½ W. | ±10% | 884 |
| R-8, 39, 28, 55, 72, 73, 81, 87 | Resistor, fixed comp. | 1.0 meg., ½ W. | ±10% | 1066 |
| R-9, 40, 16 | Resistor, fixed comp. | 220 ohms, ½ W. | ±10% | 912 |
| R-10, 23 | Resistor, fixed comp. | 2200 ohms, ½ W. | ±10% | 954 |
| R-11, 14, 38 42, 46, 89, 96 | Resistor, fixed comp. | 10,000 ohms, ½ W. | ±10% | 982 |
| R-12 | Resistor, variable comp. | 2000 ohms, linear | ±20% | 18572 |

| Symbol | Description | Rating | Tol. | Sylvania Part No. |
|---|---|---|---|---|
| R-13, 48 | Resistor, fixed comp. | 12,000 ohms, ½ W. | ±10% | 985 |
| R-17 | Resistor, fixed comp. | .56 meg., 2 W. | ±10% | 1565 |
| R-18 | Resistor, fixed comp. | 3900 ohms, ½ W. | ±5% | 965 |
| R-19 | Resistor, fixed comp. | .27 meg., ½ W. | ±10% | 1041 |
| R-20 | Resistor, fixed comp. | 33,000 ohms, ½ W. | ±10% | 1003 |
| R-21, 98 | Resistor, fixed comp. | 100 ohms, ½ W. | ±10% | 898 |
| R-22 | Resistor, fixed comp. | 1800 ohms, ½ W. | ±10% | 950 |
| R-25 | Resistor, fixed comp. | 330 ohms, ½ W. | ±10% | 919 |
| R-26 | Resistor, fixed comp. | 680 ohms, ½ W. | ±10% | 933 |
| R-30, 82, 88 | Resistor, fixed comp. | 150,000 ohms, ½ W. | ±10% | 1031 |
| R-31, 36 | Resistor, fixed W.W. | 4500 ohms, 10 W. | ±5% | 18504 |
| R-33 | Resistor, fixed comp. | 130 ohms, 2 W. | ±5% | 1413 |
| R-37, 102, 103 | Resistor, fixed comp. | 68,000 ohms, 1 W. | ±10% | 1272 |
| R-41 | Resistor, variable comp. | 5000 ohms, linear | ±20% | 18569 |
| R-43 | Resistor, fixed comp. | 39,000 ohms, 1 W. | ±10% | 1261 |
| R-44 | Resistor, fixed comp. | 56,000 ohms, 1 W. | ±10% | 1268 |
| R-45 | Resistor, fixed comp. | 47,000 ohms, 1 W. | ±10% | 1265 |
| R-50 | Resistor, fixed comp. | 6800 ohms, ½ W. | ±5% | 976 |
| R-51 | Resistor, fixed comp. | 820 ohms, ½ W. | ±10% | 936 |
| R-52 | Resistor, fixed comp. | 3300 ohms, ½ W. | ±10% | 961 |
| R-53, 85, 93 | Resistor, fixed comp. | 56,000 ohms, ½ W. | ±10% | 1523 |
| R-54 | Resistor, fixed W.W. | 5000 ohms, 10 W. | ±10% | 3803 |
| R-56 | Resistor, variable comp. | 4 meg., linear | ±15% | 18419 |
| R-57 99, | Resistor, variable comp. | 1.0 meg. linear | ±20% | 18420 |
| R-58 | Resistor, fixed comp. | 200 ohms, ½ W. | ±5% | 910 |
| R-59, 60 | Resistor, fixed W.W. | 15,000 ohms, 10 W. | ±10% | 3710 |
| R-63 | Resistor, fixed comp. | 510 ohms, 2 W. | ±5% | 1438 |
| R-66 | Resistor, fixed comp. | .82 meg., ½ W. | ±10% | 1062 |
| R-67, 68 | Resistor, var. comp. dual | 4 meg. ¼ W. linear | ±20% | 18568 |
| R-75 | Resistor, fixed comp. | 1000 ohms, ½ W. | ±10% | 940 |
| R-76, 77, 79 | Resistor, fixed comp. | .33 meg. 2 W. | ±10% | 1555 |
| R-78 | Resistor, variable comp. | 0.4 meg. linear | ±20% | 18440 |
| R-80 | Resistor, variable comp. | 50,000 ohms, .3 W. linear | ±20% | 16155 |
| R-83, 91 | Resistor, fixed comp. | 27,000 ohms, ½ W. | ±10% | 999 |
| R-84, 92 | Resistor, fixed comp. | 560 ohms, ½ W. | ±10% | 929 |
| R-86 | Resistor, variable comp. | 10,000 ohms, linear | ±20% | 18573 |
| R-90 | Resistor, variable comp. | .25 meg., ¼ W. linear | ±20% | 18570 |
| R-94, 95 | Resistor, fixed comp. | 0.1 meg., ½ W. | ±10% | 1024 |
| R-97 | Resistor, fixed comp. | 2000 ohms, 5 W. | ±5% | 11989 |
| R-100 | Resistor, adjustable W.W. | 400 ohms, ½ W. | | 11925 |
| R-101 | Resistor, fixed W.W. | 125 ohms, 10 W. | ±10% | 18729 |
| R-104 | Resistor, fixed comp. | 2700 ohms, ½ W. | ±10% | 957 |
| R-106 | Resistor, fixed comp. | 0.1 meg., 2 W. | ±10% | 1534 |
| S-1 | Switch, attenuator | | | 18447 |
| S-2, 3 | Switch, slide DPDT | | | 16429 |
| S-4 | Switch, toggle SPST | | | 16526 |
| S-5 | Switch, sweep | | | 18446 |
| S-6 | Switch, rotary non-shorting | | | 12650 |
| T-1 | Transformer, power | | | 18465 |
| T-2 | Transformer, high voltage | | | 18466 |
| | Bracket, C.R. Tube Socket Mounting | | | 18554 |
| | Bracket, Support | | | 18552 |
| | Bracket, Rectifier Tube Support | | | 18627 |
| | Bushing, Panel | | | 6185 |
| | Cable Assembly, Power | | | 16348 |
| | Cabinet | | | 18574 |
| | Cabinet, Cover Front | | | 15564 |
| | Cabinet, Cover Back | | | 18587 |
| | Chassis | | | 18556 |
| | Clamp, Cable | | | 16279 |

| Symbol | Description | Rating | Tol. | Sylvania Part No. |
|---|---|---|---|---|
| | Clamp, Tube—small base | | | 13106 |
| | Clamp, Tube—medium base | | | 18448 |
| | Clip, Tube Contact—⅜" | | | 69 |
| | Clip, Molding | | | 16407 |
| | Connector, female contact | | | 16426 |
| | Fuse, cartridge—3 amp., Type 3 AG | | | 264 |
| | Grommet, ⅜" I.D. | | | 1956 |
| | Grommet, ⅝" I.D. | | | 1954 |
| | Handle | | | 16998 |
| | Holder, Fuse | | | 481 |
| | Insulator, Potentiometer | | | 14233 |
| | Knob, pointer | | | 16252 |
| | Knob, round | | | 16253 |
| | Lamp, Incandescent—6-8 V., 0.15 amp. | | | 2828 |
| | Lamp, Glow NE-17 | | | 18848 |
| | Light, Indicator | | | 16974 |
| | Mask, C.R. Tube Ruled | | | 16637 |
| | Molding, Decorative | | | 17015 |
| | Mounting, Cathode Ray Tube | | | 18562 |
| | Panel, Front | | | 18551 |
| | Plate, Mounting—Left | | | 18626 |
| | Plate, Mounting—Right | | | 18625 |
| | Post, Binding | | | 2844 |
| | Post, Spacing | | | 18727 |
| | Ring, Mounting for C.R. Tube | | | 16547 |
| | Ring, Retainer for Tip-Jack | | | 16428 |
| | Sheet, Instruction | | | WE-94 |
| | Shield, C.R. Tube #1 | | | 18553 |
| | Shield, C.R. Tube #2 | | | 18720 |
| | Shield, Tube—T5½ | | | 18177 |
| | Shield, Tube—T6½ | | | 18278 |
| | Shield, Attenuator | | | 18545 |
| | Sleeving, Insulation | | | 4863 |
| | Socket, Tube—14 contact | | | 16546 |
| | Socket, Tube—Octal | | | 16495 |
| | Socket, Tube—4 pin | | | 13313 |
| | Socket, Tube—Lock-in | | | 18015 |
| | Socket, Tube—miniature 9 pin | | | 18277 |
| | Socket, Tube—miniature 7 pin | | | 15053 |
| | Terminal Lug | | | 6585 |
| | Window, Glass | | | 16660 |
| V-1 | Tube, electron—12AT7 | | | |
| V-2, 6, 7, 8 | Tube, electron—6AU6 | | | |
| V-3 | Tube, electron—12AU7 | | | |
| V-4, 5 | Tube, electron—7A5 | | | |
| V-9, 10 | Tube, electron—7C5 | | | |
| V-11 | Tube, electron—2X2A | | | |
| V-12 | Tube, electron—5V4G | | | |
| V-13 | Tube, electron—50X6 | | | |
| V-14 | Tube, electron—7JP1 | | | |

## PARTS FOR SHIELDED TEST LEAD

| | | | | |
|---|---|---|---|---|
| | Cable, Microphone 4' | | | 18661 |
| | Cable, Michophone 5" | | | 18662 |
| | Clip, Crocodile | | | 18667 |
| | Connector, Male Contact | | | 15792 |
| | Plug, Modern Phone Tip | | | 18728 |
| | Insulator, Clip | | | 18668 |

## APPENDIX

There are a number of books and other publications which may be found to be of value in understanding the operation of television circuits and the use of test equipment in servicing T.V. receivers. The following is a list of books which are suggested for further study:

TV Patterns. Sylvania Electric Products, Inc., Emporium, Pa.

How to Service Radios with an Oscilloscope. Sylvania Electric Products, Inc., Emporium, Pa.

PhotoFact Television Course. Howard W. Sams & Co., Indianapolis 5, Ind.

Practical Television Servicing, by J. R. Johnson and J. H. Newitt. Murray Hill Books, Inc., New York, N. Y.

Television—How It Works, by John F. Rider. John F. Rider, Publisher, New York, N. Y.

Television Simplified, by Milton Kiver. D. VanNostrand Co., New York, N. Y.

Television Servicing for Radiomen, by H. P. Manly. Frederick J. Drake Co., Wilmette, Ill.

The Video Handbook. Boland & Boyce Inc., Publishers, Montclair, N. J

Television for Radiomen, by Edward M. Noll. The Macmillan Co., New York 11, N. Y.

Basic Television, by Bernard L. Grob. McGraw-Hill Publishing Co., New York 18, N. Y.

# WARRANTY

Sylvania Electric Products Inc. warrants each new Oscilloscope manufactured by it to be free from defective material and workmanship and agrees to remedy any such defect or to furnish a new part in exchange for any part of any unit of its manufacture which under normal installation, use and service discloses such defect, provided the unit is delivered by the owner to us or to our authorized wholesaler from whom purchased, intact, for our examination, with all transportation prepaid to our factory, within 90 days from the date of sale to original purchaser and provided such examination discloses in our judgment that it is thus defective.

This warranty does not extend to any Oscilloscope which has been subjected to misuse, neglect, accident, incorrect wiring not our own, improper installation, or to use in violation of instructions furnished by us, nor to units which have been repaired or altered outside of our factory, nor to cases where the serial number thereof has been removed, defaced or changed, nor to accessories used therewith not of our own manufacture.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for us any other warranty liability.

This warranty is void unless warranty card included with instrument is filled out completely and mailed upon initial sale of the instrument by the distributor.

**SYLVANIA ELECTRIC PRODUCTS, INC.**
**1740 BROADWAY**
**NEW YORK 19, N. Y.**

PRINTED IN U. S. A.

P-70

# SYLVANIA ELECTRIC

PROPERTY OF ENGINEERING
TEST CONSTRUCTION
ITEM 2 COPY 1
48 HOUR LOAN

MP MASTER
MA31529